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INSECTICIDE RESIDUES ON GRAPES TREATED FOR CONTROL OF INSECTS

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INSECTICIDE RESIDUES ON GRAPES TREATED FOR CONTROL OF INSECTS

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In northern Ohio insecticides are generally recommended for control of insects on grapes. The usual postbloom spray program includes insecticide applications immediately after bloom, and 10, 35, and sometimes 45 days afterward. The spray applications, ending 35 to 45 days before harvest, may result in the presence of significant insecticide residues on grapes prepared for market. The addition of wetting agents, fungicides, and adhesives to make insecticide applications more effective may also affect the magnitude of residue deposits. From 1944 to 1960 studies were conducted at the Sandusky, Ohio, and Vincennes, Ind., laboratories to determine the magnitude of insecticide residues on harvested grapes. This work was carried out through the cooperation of entomologists and chemists of this Division.[1]

Methods of Analysis

Grapes in northern Ohio are grown on a 3-wire trellis in rows from 100 to several hundred feet in length. For the most part, pesticide applications are made with a hooded spray boom so that drift is minimized. The experimental spray plots consisted of single-row replicates or block treatments replicated. The sampling method was developed to be applicable to either type of experimental design.

In the field, samples were taken directly from clusters that were not removed from the vines. The berry, with 1 to 2 mm. of pedicel, was snipped from the cluster with a long-nosed citrus shear and allowed to fall directly into a 1-pint sample jar. Split, cracked, or injured grapes were not included. Three berries were taken from each sampled cluster: One from near the top, one from near the middle, and one from the end. Neither clusters nor berries were touched by hand.

In a plot of five single-row replicates, 1/5 pint of berries was collected from each row. Replicate samples were taken in the same manner. Although clusters from which the three sample berries were taken were selected at random, none were taken

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1/ In addition to the authors, H. W. Rusk and R. H. Carter participated in these studies.

from outside the trellis area. Extremely high or low clusters were not used. Because the samples were accumulated along the grape row, clusters in the open were selected as well as those protected by foliage. Clusters within the first two post areas were not included because of the possibility of residue variations owing to the change of sprayer speed, often necessary at these locations.

The basic sample for chemical analysis was 1 pint of grapes (about 260 grams). The sample jar was loosely filled so that the lid could be placed on it without crushing or bruising the berries. When a pint sample of grapes was so obtained, with five replicates, only 8 to 12 clusters distributed over the entire length were used from each row. In some tests block plots were used with the five rows for sampling selected at random.

One-pint frozen-food glass containers (straight-wall with gasket lid) were used. Samples of green, hard grapes were held in these containers, without refrigeration, for 2 to 4 days. Samples of ripe grapes were frozen as soon as possible after collecting and held in this condition until analyzed. They could also be shipped, under dry-ice refrigeration, to a laboratory within 48 hours of travel time.

The typical variation in parts per million of residues on five replicate samples of grapes from three spray plots is shown below:

Replicate No.	DDT	DDT	Parathion
1	3.9	1.1	0.40
2	2.9	0.9	.23
3	2.8	1.4	.28
4	2.2	1.0	.28
5	2.8	1.4	.25
Average	2.9	1.2	0.29

Residues were recovered from the fruit surface by stripping the grapes with an appropriate solvent. The frozen grapes were allowed to thaw and approximately 0.5 ml. of solvent per gram of grapes added; the container was then sealed and shaken intermittently for 30 minutes. After shaking, the solvent was decanted into a sample storage bottle and dried over sodium sulfate.

For DDT, TDE, and methoxychlor, redistilled benzene was the solvent. DDT was determined by either the Schechter-Haller (8) or Stiff-Castillo (10) method; TDE was determined by the Schechter-Haller (8) method; and methoxychlor by the Fairing and Warrington method (3).

Lead arsenate residues were removed with nitric acid or the fruit wet ashed with sulfuric and nitric acids. Lead residues were determined by electrolytic precipitation and titration (Wichman et al. 11), and arsenic by bromate titration of arsenic trichloride (Jones 5, and Association of Official Agricultural Chemists 1).

Other insecticides, the solvents used for recovering their residues, and the methods employed were as follows: Parathion and EPN--redistilled benzene, colorimetric method of Averell and Norris (2); malathion--carbon tetrachloride, colorimetric method of Norris et al. (7); Sevin--methylene dichloride, technique of Miskus et al. (6); Diazinon--N-hexane, for phosphate by the method Gigger (4); lindane--chloroform, BHC determined by method of Schechter and Hornstein (9).

Discussion

Since 1944 approximately 200 samples of grapes that required 700 individual analyses have been collected at harvest. The data are presented in the accompanying tables. The quantities of insecticide shown in the tables are amounts of actual toxicant rather than formulation.

Inorganic Insecticides

Lead arsenate was applied to grapes with Bordeaux mixtures and an adhesive, usually mineral oil. The results of analyses of 18 lead arsenate residues for arsenic trioxide and 10 samples for lead are given in table 1. Where more than three sprays were applied or if the final one was applied within 80 days of sampling, the lead and arsenic residues exceeded tolerances. In one instance only two sprays of lead arsenate with summer oil and B-1956 (wetter), applied 85 days before harvest, resulted in residues exceeding tolerances.

Organic Chlorine Insecticides

DDT was usually applied with a fungicide. Ferbam was the one used in most treatments, and the auxiliary materials included wetters, stickers, and mineral oil. DDT residues are reported in tables 2, 3, 4, and 5. Table 2 (tests with fungicides) shows that only 2 of 34 samples exceeded the tolerance of 7 p.p.m. The two exceptions occurred where five DDT sprays were applied. Table 3 (tests with fungicide sprays and wetter) shows that there were 14 plots in which three or four sprays left residues safely below tolerances. Table 4 (tests with fungicide sprays and spreader-sticker) shows that in 5 of 28 observations the DDT residues exceeded the tolerance. Table 5 (tests with fungicide sprays and mineral oil) shows that when mineral oil was added to the DDT spray, the residue exceeded 7 p.p.m. Generally, if DDT was applied without oil adhesive, the residue did not exceed the tolerance.

Methoxychlor (table 6) was applied at the rate of 1/2 to 1 pound per 100 gallons in three or four sprays with and without spreaders, wetters, or spreader-stickers. The maximum residue was 10.6 p.p.m., which is below the tolerance.

Lindane and TDE analyses were made on single plots (table 9). Lindane, applied in two sprays at a dosage of 1/4 pound per 100 gallons, gave a BHC residue of 0.1 p.p.m. TDE in three sprays with wetter adhesive gave 6.1 p.p.m.

Organophosphorus Insecticides

Parathion residues were determined on 53 samples (table 7) and in only one sample (from a single spray applied 7 days before harvest) was the tolerance of 1.0 p.p.m. exceeded. EPN sprays (table 8), applied up to 7 days before harvest, left residues not exceeding the tolerance of 3.0 p.p.m. Only three plots were analyzed for malathion (table 9); none of the treatments left residues approaching the tolerance of 8 p.p.m.

Diazinon was applied in three applications to a series of plots in which the final sprays were 2, 5, 10, 18, 31, or 47 days before harvest. The analyses from these plots (table 9) show that Diazinon sprays can be applied within five days of harvest without danger of exceeding the tolerance of 0.75 p.p.m.

Carbamate Insecticides

Sevin was applied in three applications to a series of plots in which the final sprays were 2, 4, 9, 17, 30, or 46 days before harvest. The analyses from these plots (table 9) show that Sevin can be sprayed up to 2 days of harvest without danger of exceeding the tolerance of 10 p.p.m.

Identification of Certain Spray Materials

To facilitate tabulating the following materials, certain abbreviations or initials are used. Chemical names of insecticides and other materials are also identified in detail. Trademarked materials are designated by an asterisk (*).

Name	Description
B-1956	phthalic glycerol alkyd resin
Bordeaux	2-2-100 mixture
Copper A	copper tetracalcium oxychloride
DDT	1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane
*Diazinon	O,O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate
EPN	O-ethyl O-p-nitrophenyl phenyl-phosphonothioate
Ferbam	ferric dimethyl dithio carbamate
Glyodin	2-heptadecyl glyoxalidine acetate
IN-2503	long-chain alcohol sulfate (wetting agent)
Lindane	99% gamma BHC
Malathion	S-(1,2-bis(ethoxycarbonyl)ethyl) O,O-dimethyl phosphorodithioate

Name	Description
Methoxychlor	1, 1, 1-trichloro-2, 2-bis(p-methoxyphenyl)ethane
*Mixol	proprietary adhesive
Oils:	
*Superla	a light mineral oil made miscible with water by certain emulsifying agents (by Standard Oil Co.)
*Sunoco Spray Oil	a medium mineral oil made miscible with water by certain emulsifying agents (by Sun Oil Co.)
Spray Adhesive	light mineral oil emulsified into "mayonnaise type" miscible summer spray oil (by DuPont)
Parathion	O, O-diethyl O-p-nitrophenyl phosphorothioate
PEPS	polyethylene polysulphide 56%, a sticking material (by Goodrich Chemical)
RFOS	resin fish oil--Good's No. 9
*Sevin	1-naphthyl methylcarbamate
S-S	spreader-sticker, sodium sulfates mixed with long-chain alcohol fatty acids and esters 88% (by DuPont)
TDE	1, 1-dichloro-2, 2-bis(p-chlorophenyl)ethane
Wetter	3 parts of kerosene and 1 part Triton B-1956, the latter being a modified phthalic glycerol alkyd resin (by Rohm & Haas)

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Table 1.--Residues from lead arsenate sprays applied at 3 pounds per 100 gallons with adhesives and Bordeaux fungicide to Concord grapes.

Number of postbloom sprays	Adhesives (per 100 gal.)		Between final spray and harvest		Residues (p.p.m.)	
	Oil 1/ (qt.)	Other materials (oz.)	Days	Rainfall (in.)	Pb	As_2O_3
2	2½	8 B-1956	85	4.88	5.7	2.7
2	2½	8 B-1956	85	4.88	8.1	4.6
3	3	16 Mixol	84	4.81	5.0	2.5
2	2½	16 Mixol	84	4.81	6.9	3.2
3	2½	8 B-1956	58	3.68	13.7	7.3
3	2½	8 B-1956	75	4.88	15.8	7.3
3	3	16 Mixol	77	4.81	27.8	13.4
3	3	16 Mixol	65	3.68	23.2	11.8
3	2½ 2/	--	66	4.63	--	10.6
3	2½ 2/	--	66	4.63	--	10.4
3	2½ 2/	16 IN-2503	79	4.81	18.9	7.4
3	2½	--	79	4.81	12.3	6.0
3	2½	--	84	10.32	--	7.9
3	2½	--	66	4.63	--	6.3
3	2½	--	66	4.63	--	5.7
3	3/8 3/	2 lb. RFOS	79	4.81	--	6.2
3	½ 3/	2 lb. RFOS	84	10.32	--	6.4
4	3 4/	--	79	4.41	--	6.0

1/ Superla unless otherwise noted.
2/ Sunoco Spray Oil.
3/ Kerosene
4/ Kerosene emulsion sticker (1 part IN-2503 9 parts kerosene).

Table 2.--DDT residues on Concord grapes from DDT-fungicide sprays.[1/]

Number of sprays	Between final spray and harvest		Residues of DDT (p.p.m.)
	Days	Rainfall (in.)	
	With 50% wettable powder at 1/4 lb./100 gal.		
4[2/]	57	8.21	1.6
	With 50% wettable powder at 1/2 lb./100 gal.		
2	74	6.88	1.0
4	38	4.11	2.4
4	38	4.42	1.4
4	38	4.11	2.0
4[2/]	57	8.21	1.6
	With 50% wettable powder at 3/4 lb./100 gal.		
2	44	5.17	2.4
2	46	5.17	5.1
2	46	5.17	6.2
2	74	6.88	0.8
3	39	4.11	3.8
3	44	5.17	2.3
3	46	5.70	1.0
3	46	5.70	1.3
3	46	5.70	1.0
3	59	5.28	1.4
4[3/]	35	4.11	6.4
4	38	4.11	2.2
4	38	4.42	2.2
4	42	5.60	3.4
4	42	5.60	3.9
4	43	5.17	2.7
4[2/]	57	8.21	2.4
5	35	1.19	4.2
5[2/]	35	1.19	11.1
5[4/]	40	4.40	3.5
5[4/]	40	4.40	3.7
5[4/]	40	4.40	3.6
5[4/]	46	3.02	7.4

Table 2.--Continued

Number of sprays	Between final spray and harvest		Residues of DDT (p.p.m.)
	Days	Rainfall (in.)	
	With 75% wettable powder at 3/4 lb./100 gal.		
2	75	6.63	0.6
2	35	2.38	2.5
4	34	2.38	3.2
4	35	2.38	3.0
4	35	2.38	4.9

1/ Ferbam in one or more postbloom sprays.
2/ Catawba variety.
3/ Bordeaux fungicide in one or more postbloom sprays.
4/ Ferbam in three postbloom sprays with Bordeaux in fourth postbloom spray.

Table 3.--DDT residues on Concord grapes from DDT-ferbam sprays containing additive (DDT wettable powder at 3/4 pound per 100 gallons).

Number of sprays	Additive (oz./100 gal.)	Between final spray and harvest		Residues of DDT (p.p.m.)
		Days	Rainfall (in.)	
3	Wetter 4	33	3.53	4.5
3	3	37	4.40	6.4
3	3	37	4.40	6.1
3	4	39	3.35	4.4
4	3	37	4.40	4.1
4	3	37	4.40	4.6
4	3	37	4.40	5.4
3	PEPS 4	50	5.28	2.4
4 1/	4	38	4.11	2.0
4	4	38	4.11	2.4
4	4	38	2.38	4.8
4	4	38	2.38	2.9
4	Glyodin 16	36	2.57	3.6
4	S-S 4	43	5.17	1.8

1/ DDT at 1/2 lb. per 100 gal.

Table 4.--Residues on Concord grapes from DDT-ferbam sprays with spreader-sticker added (DDT at 3/4 pound per 100 gallons).

Number of sprays	Spreader-Sticker (oz./100 gal.)	Between final spray and harvest		Residues of DDT (p.p.m.)
		Days	Rainfall (in.)	
		With 50% wettable powder		
2	2	76	5.94	1.4
2	2	76	5.94	1.7
2	2	76	5.94	1.4
2	2	76	5.94	1.9
2	2	81	7.90	1.7
2	2	81	7.90	2.0
2	2	81	7.90	1.6
3	2 1/	28	0.92	3.2
3	2 1/	42	2.95	2.0
4	2 1/	34	1.62	5.4
4	2 1/	35	1.62	3.1
4	2 1/	35	1.62	3.6
4	4	42	5.60	6.9
4	4	43	5.17	10.2
4	4 2/	36	2.57	5.3
		With 75% wettable powder		
3	2	34	2.38	5.6
4	2 1/	32	2.38	4.4
4	2 1/	32	2.38	4.4
4	2 1/	32	2.38	4.6
4	2 1/	32	2.38	3.4
4	2	34	2.38	7.0
4	2	35	2.38	7.5
4	2	37	2.38	6.4
4	2	37	2.38	6.2
4	2 1/	37	2.38	3.7
4	4 2/	37	2.38	7.2
4	4 2/	37	2.38	7.2
4	4 1, 2/	37	2.38	4.5

1/ Applied in first two spray applications only.
2/ Wetter.

Table 5.--Residues on Concord grapes[1/] from DDT[2/]-fungicide[3/] sprays with mineral oil and B-1956 added (DDT 50% wettable powder).

Plot No.	Number of DDT sprays	Additives		Between final DDT spray and harvest		Residues of DDT (p.p.m.)
		Oil (oz.)[4/]	B-1956 (oz.)	Days	Rainfall (in.)	
1	1	80	4	82	7.77	9.8
2	5	16	2	46	3.02	16.0
3	5	8	1	35	1.19	7.8
4	5	8	1	35	1.19	15.6
5[5/]	4	16	1	55	3.02	9.8
6[6/]	3	32	-	55	3.02	10.2
7[7/]	4	32	-	49	3.02	5.8
8	3	24	4	29	4.11	11.4
9[8/]	2	4	4	49	3.02	4.6
10[8/]	2	4	4	49	3.02	5.6

1/ Catawba variety in plot 4.

2/ DDT at 3/4 lb./100 gal. except plot No. 1 at 1/2 lb.

3/ Bordeaux in all plots except ferbam in plots 3, 4, and 5; Bordeaux followed by 1 ferbam spray in plot 7.

4/ Superla in plots 1 through 7; spray adhesive in plot 8 and kerosene in plots 9 and 10.

5/ Oil in first two sprays; 4 oz. of wetter in last two sprays.

6/ Oil in first spray only; 4 oz. of wetter in last two sprays.

7/ Oil in first two sprays; last two sprays applied with 4 oz. of B-1956 and 4 oz. of kerosene.

8/ Oil applied in 2 sprays (plot 9) and 3 sprays (plot 10) without DDT prior to DDT sprays.

Table 6.--Residues from methoxychlor 50% wettable powder sprays applied to grapes with ferbam at 2 pounds per 100 gallons and an additive.

Number of sprays	Dosage of methoxychlor (lb./100 gal.)	Additive (oz.)	Between final spray and harvest		Residues of methoxychlor (p.p.m.)
			Days	Rainfall (in.)	
1	3/4	2 S-S	43	2.95	0.7
1	3/4	2	76	5.94	1.6
2	3/4	2	35	1.62	2.3
2	3/4	2	87	7.90	0.4
2	1	8 PEPS 1/	38	4.42	4.5
2	1	-	38	4.11	2.5
2	1	-	46	5.81	6.0
2	1	-	46	5.81	4.8
2 2/	1	4 Wetter	75	6.39	1.5
2 2/	1	4	75	6.39	0.8
3	3/4	2 S-S	28	0.92	1.8
3	3/4	2	42	2.95	1.4
3	3/4	2	33	1.62	2.8
3	1	-	46	5.70	0.5
3	1	-	46	5.70	.2
3	1	-	46	5.70	1.5
4	1/2	2 S-S	34	2.38	4.5
4	3/4	2	34	1.62	3.7
4	1	-	42	5.60	6.7
4	1	-	42	5.60	10.6

1/ Second spray only.
2/ No ferbam applied.

Table 7.--Residues from parathion sprays applied to grapes with supplemental insecticides, ferbam,[1/] and additives.

Number of sprays	Dosage of parathion (oz./100 gal.)	Supplemental insecticide (lbs./100 gal.)	Additive (oz./100 gal.)	Between final spray and harvest		Residue of parathion (p.p.m.)
				Days	Rainfall (in.)	
1	1.6	3/4 DDT	2 S-S	76	5.94	0.0
1	2.4	3/4	4 Wetter	7	0.30	1.56
1	2.4	3/4	2	37	4.40	<0.1
1	2.4	1 methoxychlor	-	46	5.81	<.1
1	2.4	3/4 DDT	-	46	5.17	<.1
1	2.4	3/4	2 S-S	76	5.94	.0
1	2.4	3/4	2	76	5.94	.0
1	2.4	3/4	2	76	5.94	.0
1	2.4	3/4	8 PEPS	76	5.94	.0
1	2.4	3/4	-	93	5.17	<.1
1	2.4	1 methoxychlor	-	93	5.81	<.1
1	4.0	3/4 DDT	-	38	4.42	.3
1	4.0	3/4	-	38	4.11	.4
1	4.0	3/4	-	57	8.21	<.1
2	1.2	5/8	2 S-S	76	5.94	.0
2	1.2	5/8	2	76	5.94	.0
2	2.0	3/4	-	38	4.42	.3
2	2.4	3/4	2 S-S	10	0.51	.7
2	2.4	1 methoxychlor	2	10	.51	.5
2	2.4	3/4 DDT	4 Wetter	20	1.58	<.1
2	2.4	1 methoxychlor	2 S-S	34	1.62	.2
2	2.4	3/4 DDT	2	34	1.62	.2
		1 methoxychlor				
2	2.4	3/4 DDT	2 S-S	34	1.62	<.1
2	2.4	3/4	2 Wetter	37	4.40	<.1
2	2.4	3/4	2	37	4.40	<.1

2	2.4	3/4	-	40	4.40	< .1
2	2.4	3/4	-	40	4.40	< .1
2	2.4	3/4	-	40	4.40	< .1
2	2.4	1 methoxychlor	2 S-S	42	2.95	< .1
2	2.4	3/4 DDT	2	42	2.95	.2
2	2.4	3/4	-	44	5.17	< .1
2	4.0	3/4	-	38	4.42	.2
3	1.2	3/4	-	46	5.70	< .1
3 2/	1.2-2.4	5/8	-	20	1.58	< .1
3	2.4	3/4	-	46	5.70	< .1
3	2.4	-	-	46	5.70	< .1
3	3.6	-	-	46	5.70	< .1
3	4.0	-	-	67	9.18	< .1
4	1.2	2/5 DDT	2 S-S	32	2.38	< .1
4	1.2	2/5	2	32	2.38	< .1
4	1.5	1/2	2	32	2.38	< .1
4	1.5	1/2	2	32	2.38	< .1
4	2.0	1/2	-	38	4.11	.4
4	2.0	3/4	-	38	4.42	< .1
4	2.0	3/4	-	57	8.21	< .1
4	2.0	3/4	-	57	8.21	< .1
4	2.0	-	-	57	8.21	< .1
4	2.4	3/4 DDT	2 S-S	34	2.38	< .1
4	2.4	3/4	-	35	2.38	< .1
4 2/	2.4	3/4	2 S-S	35	2.38	< .1
4	2.4	3/4	-	42	5.60	.7
4	2.4	1 methoxychlor	-	42	5.60	.9
4	4.0	-	-	57	8.40	< .1

1/ Ferbam applied at 2 pounds per 100 gallons.
2/ No ferbam applied.

Table 8.--Residues from EPN sprays applied with supplemental insecticides, a fungicide, and an additive to grapes.

Number of sprays	Dosage of EPN (oz./100 gal.)	Supplemental insecticide (lb./100 gal.)	Fungicide (lb./100 gal.)	Additive (oz./100 gal.)	Between final spray and harvest		Residues of EPN (p.p.m.)
					Days	Rainfall (in.)	
1	4.0	None	None	4 Wetter	7	0.30	2.5
1	4.3	3/4 DDT	2 Ferbam	2 S-S	76	5.94	0.0
1	4.3	3/4 Methoxychlor	2	2	76	5.94	.0
1	4.3	3/4 DDT	2	2	76	5.94	.0
2	3.6 (emul.)	1 Methoxychlor	None	4 Wetter	20	1.58	.4
2	4.0	3/4 DDT	2 Ferbam	2 S-S	10	0.51	1.6
2	4.0	3/4	None	4 Wetter	20	1.58	0.3
2	4.0	3/4	None	4	20	1.58	.3
2	4.0	1 Methoxychlor	None	None	20	1.58	.2
2	4.0	3/4 DDT	2 Ferbam	2 S-S	34	1.62	.7
2	4.0	3/4	2	4 Wetter	37	4.40	$<$ .1
2	4.0	1 Methoxychlor	None	4	20	1.58	.3
3	4.3	3/4 DDT	2 Ferbam	2 S-S	34	2.38	.3
3	6.0	None	2	None	46	5.70	$<$ .1
4	4.3	3/4 DDT	2	2 S-S	32	2.38	.6
4	4.3	1/2 Methoxychlor	2	2	34	2.38	.4

Table 9.--Residues for Diazinon, lindane, malathion, Sevin, and TDE sprays applied to grapes with supplemental insecticide, ferbam,[1] and wetter.

Number of sprays	Supplemental insecticide (lbs./100 gal.)	Between final spray and harvest		Residues (p.p.m.)
		Days	Rainfall (in.)	
		Diazinon (25% WP) at 1/2 lb./100 gal.		Diazinon
3	3/4 DDT	47	6.15	<0.1
3	3/4	31	2.48	< .1
3	3/4	18	1.49	.2
3	3/4	10	1.27	.2
3	3/4	5	1.27	.5
3	3/4	2	0.48	1.1
		Malathion (25% WP) at 5/8 lb./100 gal.		Malathion
1[2]	3/4 DDT	7	0.30	0.1
1[3]	3/4	7	.30	4.0
3[3]	3/4	20	1.58	<0.1
		Lindane (25% WP) at 1/4 lb./100 gal.		BHC
2[4]	-	45	4.40	0.1
		Sevin (50% WP) at 1/2 lb./100 gal.		Sevin
3	-	46	6.15	0.4
3	-	30	2.58	.6
3	-	17	1.49	1.4
3	-	9	1.27	3.2
3	-	4	1.27	4.2
3	-	2	0.48	4.7
		TDE (50% WP) at 1 lb./100 gal.		TDE
3	-	41	3.53	6.1

1/ Ferbam applied at 2 lbs./100 gal. except where indicated.
2/ Bordeaux (3-3-100) instead of ferbam.
3/ No ferbam applied.
4/ Copper A ($1\frac{1}{2}$ lbs. per 100 gal.) instead of ferbam.

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